

SHORT COMMUNICATION

FIRST CRETACEOUS TURTLE FROM ANTARCTICA

MARCELO DE LA FUENTE,^{1,2} FERNANDO E. NOVAS,^{*,1,3} MARCELO P. ISASI,^{1,3} JUAN M. LIRIO,⁴ and HÉCTOR J. NUÑEZ⁴; ¹Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET); ²Museo Municipal de Historia Natural de San Rafael, Parque Mariano Moreno S/N° San Rafael (5600), Mendoza, Argentina; ³Museo Argentino de Ciencias Naturales “Bernardino Rivadavia,” Av. Ángel Gallardo 470, Buenos Aires (1405), Argentina, fernovas@yahoo.com.ar; ⁴Dirección Nacional del Antártico–Instituto Antártico Argentino, Cerrito 1248, Buenos Aires (1010), Argentina

The James Ross Basin is located on the northeastern extreme of the Antarctic Peninsula and centered on the James Ross Archipelago (del Valle et al., 1992). This basin accumulated one of the thickest and most complete sedimentary sequences of Early Cretaceous to early Cenozoic age exposed in the Southern Hemisphere. One of the most fossiliferous horizons of the James Ross Basin is the Upper Cretaceous Santa Marta Formation (Olivero et al., 1986), estimated to be late Coniacian through latest Campanian on the basis of strontium isotope stratigraphy (McArthur et al., 2000). The Santa Marta strata have yielded a diverse assemblage of both marine and terrestrial fossil vertebrates (see overview by Reguero and Gasparini, 2007), including sharks (Clamydoselachidae, Squatinidae), actinopterygian fishes (Aulopiformes Enchodontidae, and Actinopterygii indet.; Richter and Ward, 1990; Kriwet et al., 2006), mosasaurs (Tylosaurinae; Novas et al., 2002), plesiosaurs (Polycotylidae; D’Angelo et al., 2008), and dinosaurs (Ankylosauria; Gasparini et al., 1987, 1996; Olivero et al., 1990). Here we report on a partially preserved chelonoid carapace found in the Santa Marta Formation, thus constituting the oldest known turtle from Antarctica. The new discovery enlarges the meager fossil record of turtles from this continent, currently restricted to an Eocene dermochelyid chelonoid reported from the La Meseta Formation (de la Fuente et al., 1995).

Institutional Abbreviations—MACN Pv, Paleontología de Vertebrados Collection, Museo Argentino de Ciencias Naturales de Buenos Aires, Argentina.

SYSTEMATIC PALEONTOLOGY

TESTUDINES Batsch, 1788
 CHELONIOIDEA Baur, 1893
 CHELONIOIDEA incertae sedis
 (Fig. 1A, B)

Material—MACN Pv 19.780, made up by a fragmentary shell preserving a large nuchal bone, the first and second right peripherals, the first through fifth left peripherals, the left first and second costal bones, and fragments of the first and second neural ossifications. One of us (J.M.L.) discovered the specimen in January 2004.

Locality and Horizon—The specimen was collected from massive, fine- to medium-grained sandstone and silty sandstones of the Alfa Member of the Santa Marta Formation (late Coniacian through latest Campanian; Olivero et al., 1986; McArthur et al., 2000), cropping out close to Col Crame site (63°49’S, 57°53’W), northwest of James Ross Island, northeast Antarctic Peninsula. Nearby, but at a level 25 m below, the remains of a polycotylid plesiosaur were recovered (D’Angelo et al., 2008). The Alfa Member of the Santa Marta Formation (Olivero et al., 1986) has been originally dated as early Santonian to early Campanian in age on the basis of molluscs and dinoflagellate cysts (Crame et al.,

1991; Keating, 1992). However, recent studies based on strontium isotope (⁸⁷Sr/⁸⁶Sr) stratigraphy (McArthur et al., 2000) suggest that the Coniacian-Santonian boundary is situated 150 m above the base of the Santa Marta Formation. Because the turtle specimen comes from about 90 m below this boundary, we infer a late Coniacian age for this fossil.

DESCRIPTION

The specimen is interpreted as an adult individual because of the lack of costo-peripheral fontanelles in the preserved portion of the shell. The estimated maximum anteroposterior length of the carapace is 405 mm.

No scute sulci are apparent on the dorsal surface of the carapace; yet the sutures among bones of the carapace are easy to discern. We cannot dismiss the possibility that the absence of scute sulci in MACN Pv 19.780 reflects a preservational artifact, but the virtual absence of shell scales is a diagnostic condition of living and fossil dermochelyids (Hirayama, 1997).

The nuchal bone is wider than long. Its ventral surface exhibits a slight prominence, resembling that present in *Toxochelys* sp. (Zangerl, 1953:fig. 81) and *Toxochelys moorevillensis* (Zangerl, 1953:199). A slight prominence of the nuchal bone may be interpreted as homologous with the distinct knob present in most chelonoid turtles (Zangerl, 1953; Parham, 2005). The anterior margin of the nuchal bone is straight, in contrast to the emarginated condition present in the protostegid *Terlinguachelys fishbecki* and the chelonid *Zangerchelys arkansaw* (Lehman and Tomlinson, 2004; Schmidt, 1944; Hirayama, 2006). In MACN Pv 19.780 the nuchal bone is trapezoidal in outline, with the wider base located posteriorly, in contrast to the condition in the protostegid *Protostega gigas*, in which the wider base is the anterior one. MACN Pv 19.780 differs from the dermochelyid *Corsochelys haliniches* (Zangerl, 1953, 1960) in which the nuchal bone is quadrangular in outline.

As in other adult chelonoids, post-nuchal fontanelles are absent on the posterior nuchal margin of the shell, excepting adult specimens of *Ctenochelys* and *Toxochelys* (Zangerl, 1953) in which post-nuchal fontanelles are present. The first peripheral bone is sub-triangular in shape, whereas the second, third, and fourth peripherals are sub-quadrangular. Peripherals 2 to 4 form a protruding anterolateral margin of the carapace, as in other chelonoids (e.g., *Eretmochelys imbricata*, *Caretta caretta*, *Chelonia mydas*, *Lepidochelys olivacea*, *Natator depressus*, *Procolpochelys grandaeva*, *Puppigerus camperi*, *Santanachelys gaffneyi*; Zangerl and Turnbull, 1955; Moody, 1974; Zangerl et al., 1988; Hirayama, 1998; Wyneken, 2001).

Neural bones are represented by fragments of the first and the second ones. They are relatively thin (5 mm along their edges) in comparison with the thick and keeled neural bones of protostegids (e.g., *Notochelone costata*, *Terlinguachelys fishbecki*, *Protostega gigas*). However, the outline of these bones is difficult to determine, and it is uncertain whether the neural bones are broad

*Corresponding author.

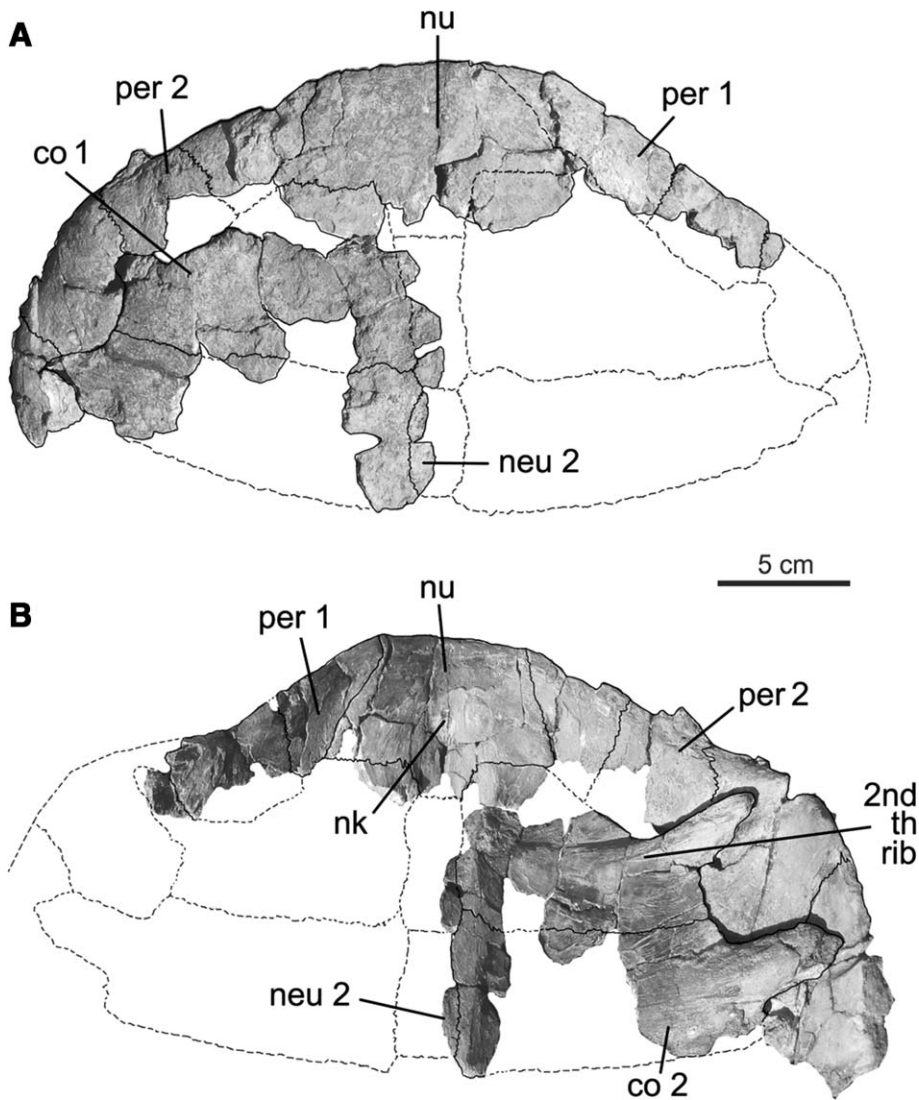


FIGURE 1. Chelonioidea indet., carapace (MACN Pv 19.780). **A**, dorsal view; **B**, visceral view. **Abbreviations:** **co 1**, costal bone 1; **co 2**, costal bone 2; **neu 2**, neural bone 2; **nk**, nuchal knob; **nu**, nuchal bone; **per 1**, peripheral bone 1; **per 2**, peripheral bone 2; **2nd th rib**, second thoracic rib.

and hexagonal as in cheloniids, or narrow and rectangular as in protostegids and dermochelyids (Hirayama, 1994).

Preserved costal and peripheral bones are indicative of a high degree of ossification of the carapace of MACN Pv 19.780, which is different from dermochelyids and protostegids in which the ossification is much more reduced.

On the left side of the carapace, the external portions of the second and third thoracic ribs are well preserved. These ribs are wide and thick, similar to the condition in some other chelonoid turtles (e.g., *Puppigerus camperi*, Moody, 1974:fig. 14). The tip of the second thoracic rib fits between the visceral surfaces of the third and fourth peripheral bones, and that of the third thoracic rib fits between the fourth and fifth peripherals.

The first thoracic rib is not preserved in MACN Pv 19.780. However, we infer that it was short because of the absence of remains of this rib on the anterior face of the second thoracic rib. In this regard, the Antarctic specimen may have shared with most of the sea-turtles a short first thoracic rib, in contrast to the condition seen in *Santanachelys gaffneyi*, originally considered a basal chelonoid (Hirayama, 1998) but more recently as a stem cryptodiran (Joyce, 2007).

On the visceral surface of the second, third, and fourth peripheral bones, as well as on the lateral extreme of the left first costal bone, there is no a structure over which the axillar plastral buttress could be fitted. This suggests that the plastron of MACN Pv 19.780 did not reach the peripherals laterally, as it does in the remaining chelonoids (Parham, 2005).

DISCUSSION

Taxonomy

Turtle groups frequently recorded in southern Gondwana during the Cretaceous and Paleogene include continental chelids, meiolaniids, and some genera (i.e., *Otwayemys* and *Chubutemys*) that are closely related to the Meiolanidae (de la Fuente, 2007, and references therein; Gaffney, 1996; Gaffney et al., 1998, 2007), as well as marine cheloniids and protostegids (Gaffney, 1981; Hirayama, 1994, 1997, 1998; Kear, 2003; Kear and Lee, 2003; de la Fuente and Casadio, 2000; de la Fuente et al., 2009). The new Antarctic specimen lacks the synapomorphic features characterizing Chelidae, Meiolaniidae, *Chubutemys*, and *Otwayemys*, indicating that MACN Pv 19.780 is not related to any of these taxa. On the contrary, the new Antarctic turtle exhibits features

interpreted as synapomorphic of Chelonioidea, including a plastron that does not reach the peripheral bones laterally (Parham, 2005), a prominence on the visceral surface of the nuchal bone (Parham, 2005), and reduction of the distal portion of the costal bones (Hirayama, 1998).

Fossil sea turtles are usually referred to one of the two lineages of extant Chelonioidea (Hirayama, 1994, 1997, 1998; Joyce et al., 2004; Lehman and Tomlinson, 2004): a clade leading to extant cheloniids (Pancheloniidae sensu Joyce et al., 2004), and another branch leading to the extant *Dermochelys* (*Pandermochelys* sensu Joyce et al., 2004). Recent studies (Kearn and Lee, 2005) depicted *Ctenochelys* and *Toxochelys* as stem chelonioids rather than crown chelonioids as previously thought (Hirayama, 1994, 1997, 1998). Several features of the Antarctic specimen (e.g., absence of post-nuchal fontanelles; plastron that does not reach the peripheral bones laterally; presence of a prominence on the visceral surface of the nuchal bone; reduction of the distal portion of distal costal bones) support its referral to Chelonioidea; the position of MACN Pv 19.780 within Chelonioidea will remain unresolved until more anatomical information on this turtle become available.

Currently, the fossil record of Cretaceous chelonioids from the Southern Hemisphere includes the extinct Protostegidae and extinct forms of the Cheloniidae. Protostegids currently documented in southern locations include *Notochelone costata*, *Craiochelone berneyi*, and *Bouliachelys suteri* from the upper Albian Toolebuc Formation of Queensland, Australia (Owen, 1882; Longman, 1915; Kear and Lee, 2003; Gaffney, 1981; Kear, 2003), *Santanachelys gaffneyi* from the upper Aptian to lower Albian Santana Formation of Ceará, Brazil (Hirayama, 1998), and Protostegidae indet. from the upper Aptian Paja Formation of Boyacá, Colombia (de la Fuente and Goñi, 1983). The only other cheloniid at present documented from Gondwana is *Euclastes* sp. from the Maastrichtian Quiriquina Formation of southern Chile (Lynch and Parham, 2003; de la Fuente, 2007; de la Fuente et al., 2009). To these Australian–South American discoveries is added the record of a possible marine turtle (Chelonioidea?) from the southern coast of South Africa (Lapparent de Broin, 2000).

Although the new Antarctic turtle is incompletely known, its discovery increases the taxonomic diversity of the marine reptile fauna that inhabited southern seas at the end of the Cretaceous.

Paleobiogeography

The paleolatitude of the northern tip of the Antarctic Peninsula was approximately 65°S at the end of the Cretaceous (~85 Ma; Lawver et al., 1992), being roughly the same as it is today. Paleobotanical evidence in the form of angiosperm leaves from the lower levels of the Santa Marta Formation (Hayes et al., 2006), suggests that annual temperatures ranging from 15°C through 23°C (mean 19°C) for this northern region of Antarctica. Furthermore, studies of oxygen isotope ratios for belemnites collected from the Santa Marta Formation indicate that sea water paleotemperatures were about 13.6°C (Pirrie and Marshall, 1990) to 13.5°C (Ditchfield et al., 1994).

The specimen here described constitutes one of the few Cretaceous marine turtles that have been documented closer to a polar location, including the northern hemisphere. In this regard, analysis of the early Campanian record of marine reptiles from the Western Interior Seaway of North America has shown (Nicholls and Russell, 1999) that the highest taxonomic diversity and numerical abundance of turtles was restricted at lower paleolatitudes. Marine turtles remain absent from the Smoking Hill Formation cropping out along the Anderson River, a high-paleolatitude locality in Canada (~70°N) comparable to that of James Ross Island in Antarctica (Smith and Briden, 1977). In North America, the most northerly records of marine turtles

come from the Pierre Shale Formation of Manitoba (Canada) at an approximate paleolatitude of 40°N (Smith and Briden, 1977).

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